

## Wu, Jennifer

---

**From:** Wu, Jennifer  
**Sent:** Tuesday, March 28, 2017 2:53 PM  
**To:** Emi Kondo - NOAA Affiliate  
**Subject:** FW: Regarding effects of pH 9.0 on salmonids

Emi, thanks for your voicemail. I'm fine talking tomorrow with Bill and Malenna, but here's a little more information on pH effects on fish. See below for info from Lil. EPA's Water Quality Criteria document from 1986 (EPA 440/5-86-001) also includes information on how the pH EPA-recommended criteria were developed. (Long link below: pages 233-239)

<https://nepis.epa.gov/Exe/ZyNET.exe/00001MGA.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1986+Thru+1990&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C86thru90%5CTxt%5C00000000%5C00001MGA.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL>

Long-term constant exposure to high pH levels could be harmful to fish. Based on model assumptions and studies and the diurnal nature of pH problems, exposure to high pH would only occur when algae are taking up carbon dioxide during photosynthesis during the day, since carbon dioxide acts like carbonic acid. Here are some diagrams from a book called, "Biogeochemistry of Wetlands: Science and Applications, Reddy, K.R. and De Laune, R.D." Though this is for wetlands, the chemistry is the same. If you feel this is useful for Bill and Malenna, feel free to share it with them. Thanks - Jenny

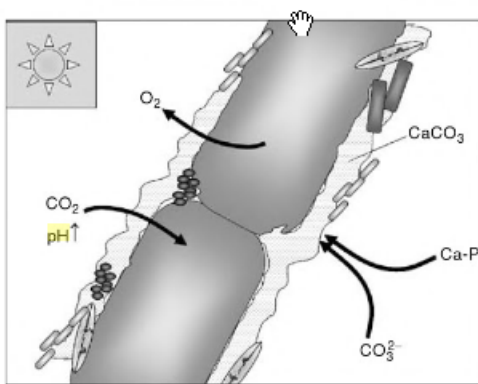


FIGURE 9.63 A schematic showing phosphorus cycling in **periphyton** mats during daytime.

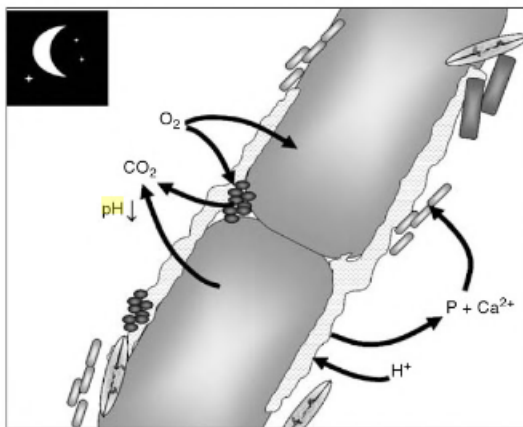


FIGURE 9.64 A schematic showing phosphorus cycling in **periphyton** mats during nighttime.

**From:** Herger, Lillian  
**Sent:** Monday, March 27, 2017 3:15 PM  
**To:** Wu, Jennifer <Wu.Jennifer@epa.gov>  
**Subject:** Regarding effects of pH 9.0 on salmonids

Hi Jenny,

A literature review led USEPA (1986) concluded that a pH range of 6.5 to 9.0 provides adequate protection for freshwater fish and benthic invertebrates. Outside of this range, fish can suffer adverse physiological effects," increasing in severity as the degree of deviation increases until lethal levels are reached". So 6.5-9 is the safe range and for maximum productivity 6.5-8.5 should be maintained.

As the literature used for the USEPA limits is quite old, I occasionally check for newer information to see if pH effects to fish (including salmonids) have been re-visited. I have not seen anything new regarding elevated (>9) pH. It looks like most of the reviews are old. High pH >9 is still at the value described as being harmful. A pH of 9.0 is considered at/near upper tolerance limit for rainbow trout (Wagner et al. 1997). I also looked specifically for high pH studies for salmon but did not find anything relevant that indicated that the situation has changed.

Low pH, however, is still a research topic, mostly with regard to embryo development. Probably because new species of fish are being introduced as aquaculture species. Of course besides the toxicity of pH itself, pH influences many other water constituents such as toxicity of some metals and conversion of ammonium to ammonia, which can result in other problems for fish. Another consideration is the combination of stress of high pH with other water quality conditions such as high or low water temperature. Also, acclimation can affect the adverse effects of elevated pH on fish.

That is the quick answer.

Lil

Lillian Herger, fish biologist  
USEPA Region 10  
Seattle, WA  
206-553-1074  
[Herger.Lillian@EPA.gov](mailto:Herger.Lillian@EPA.gov)

USEPA. 1986. Quality criteria for water 1986. Office of Water Regulations and Standards. Washington, D.C. EPA/440/5-86-001.

Wagner, E.J., T. Bosakowski, and S. Intelmann. 1997. Combined effects of temperature and high pH on mortality and the stress response of rainbow trout after stocking. 126:985-998